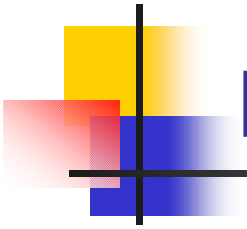


Exotics Triggers

- Questions :

- a) Review each trigger path used by your group. What is the physics goal or goals of each trigger and how much integrated luminosity is needed for a significant result? Is there adequate rate for triggers aimed at studying backgrounds? What is the impact of recent adjustments to the trigger table?
- b) What is the S/B for each trigger path? Can cuts be changed at any level to improve S/B?
- c) What additional trigger capabilities would improve the situation, how and by how much? For instance, removal of the 12kHz limit, level 2 muon board, Si tracking at level 3.

Triggers and Datasets

- High pt ele and muon –stream B - EW
  - Very high ele included
- SUSY dileptons – edil*
  - Triggers
- MET, MET + HF –
- TAUS, lepton + track
- Photon

Exotic triggers

what	stream	cdf4718 code	who
tau/lep+track	E	3.40-3.42	Alexei /Fedor
MET	E	3.32, 3.33 et al	Dmitri T./T.Munar
photon	C	3.25 to .31	Beate/Ray
multi-lepton	E	3.35	M. Giordani
high pt lepton	B	3.8, 3.9 et al	EW/ Kaori M.
high pt bjet	E	....	T.Dorigo

MET

Met Trigger Paths & Dataset

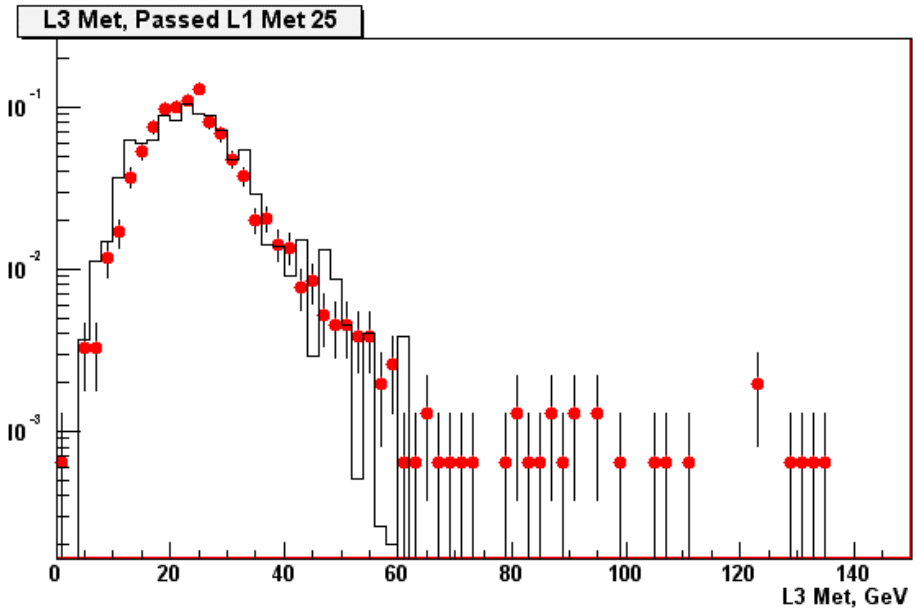
- 1.Path MET35_&_TWO_JETS
- 2.Path MET45
- 3.Path MET_BJET
  - In after shut down

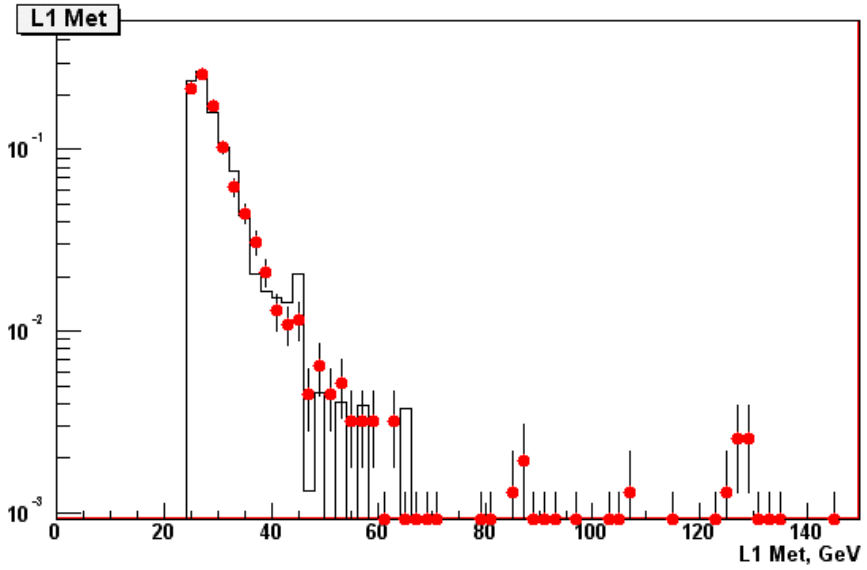
- All in the Stream E → *emetXX*
- New data is processed with 4.8.4a (runs 152123:152602)
- Reprocessing of old data should start soon

Backup trigger included – MET_L3PS100_L1_MET25

MET at L1 and L3

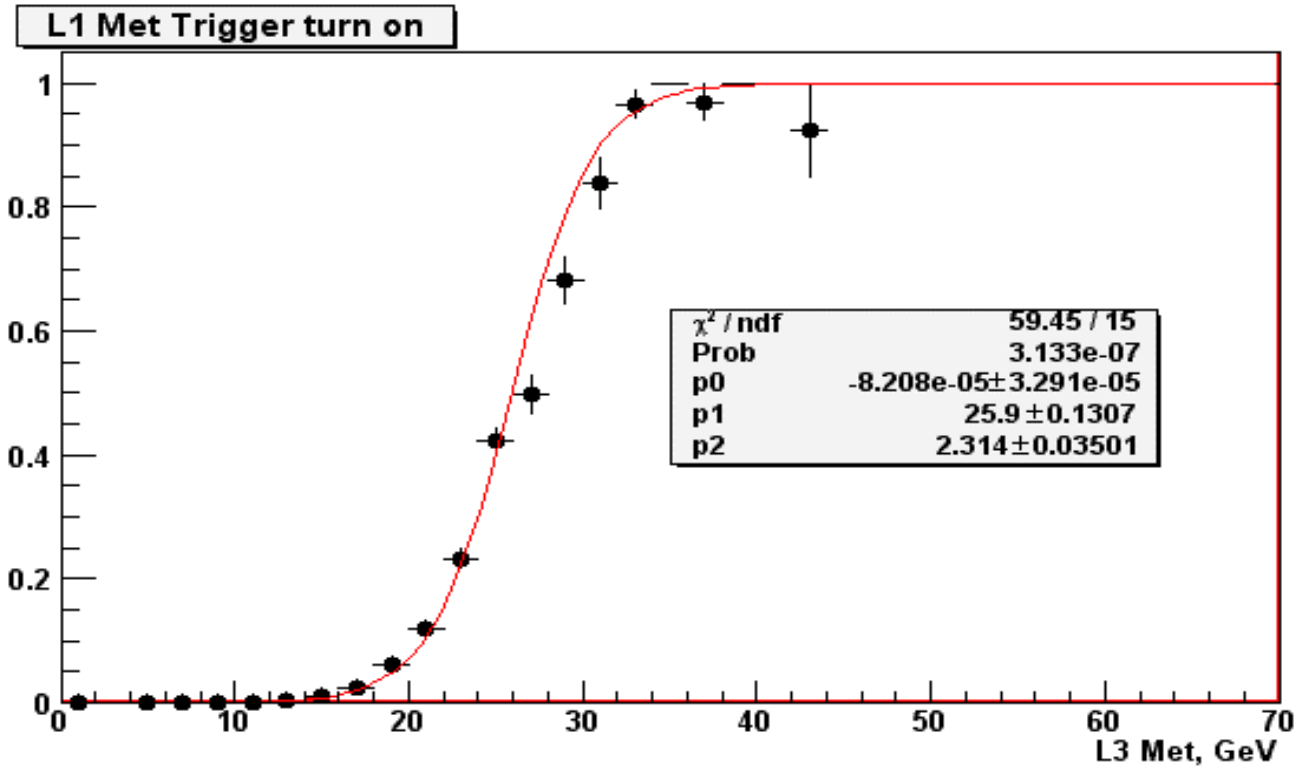
Jet 20 data vs QCD sim





Dmitri Tsybychev

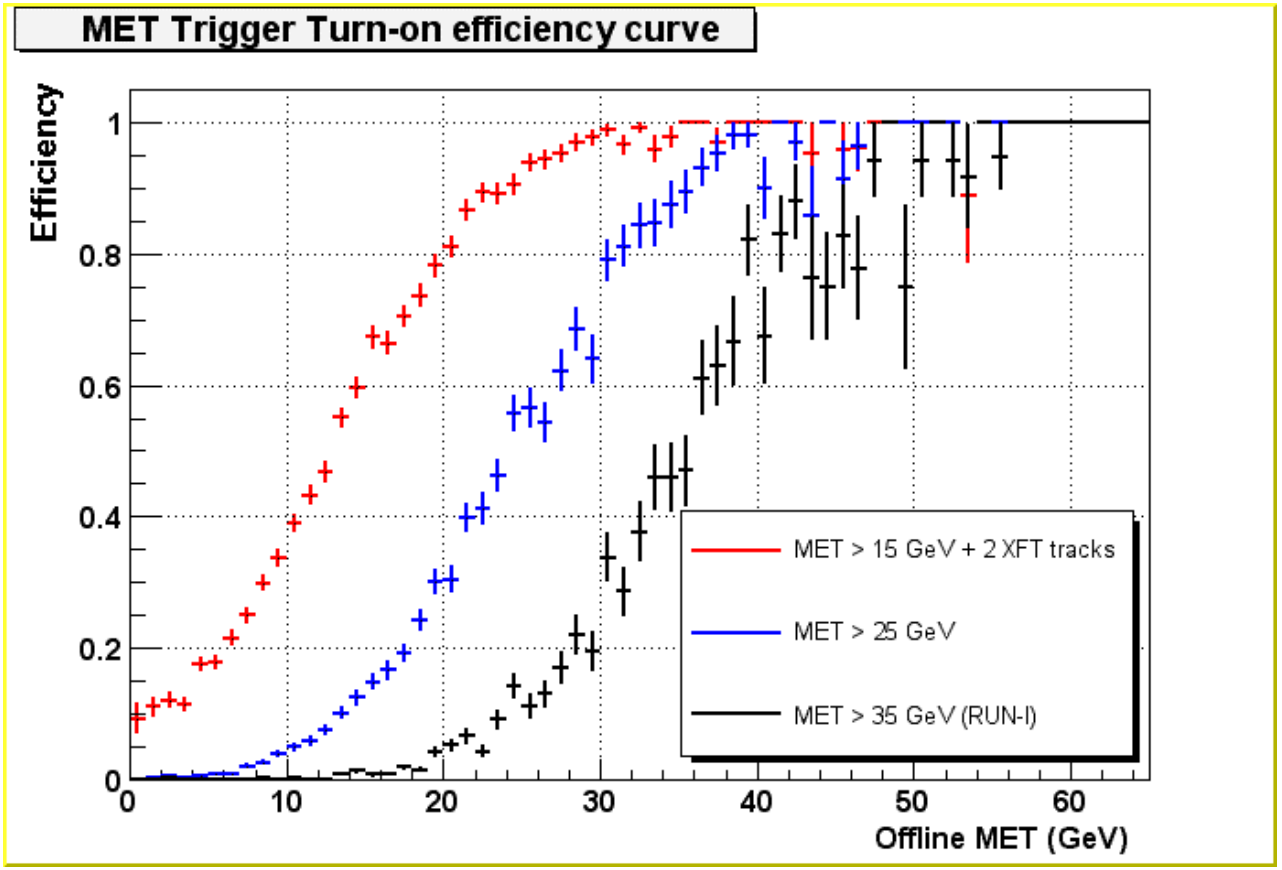
Turn on efficiency curve



Jet-20

Dmitri Tsybychev

Turn on efficiency curve

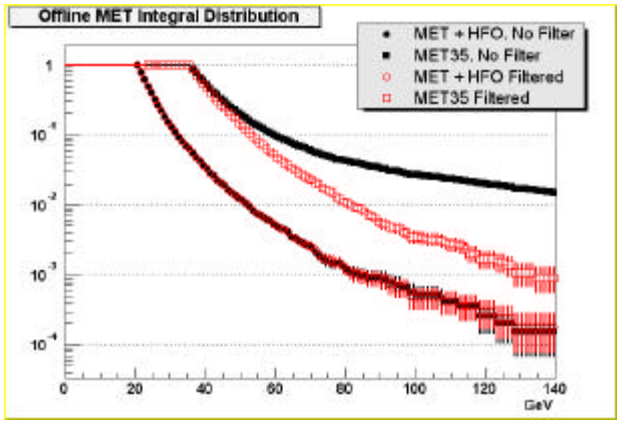


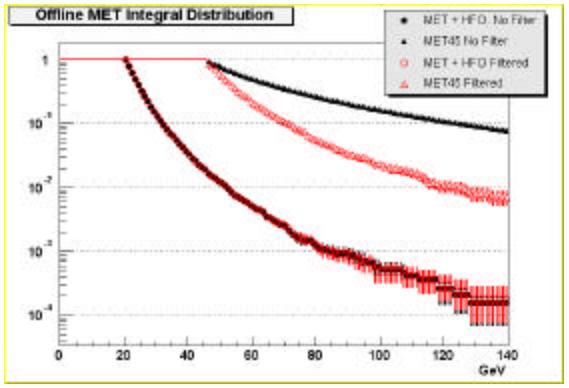
Jet-20

T.Munar

MET cleanup

integral distribution for the MET+HFO, MET-45 and MET-35 triggers with cleanup cuts





CHA threshhold energy (GeV) 1.0
PHA threshhold energy for inner towers 2.0
PHA threshhold energy for outer towers 3.0
WHA threshhold energy (GeV) 1.0

Number of out-of-time towers in the event cut (less_equal) 5

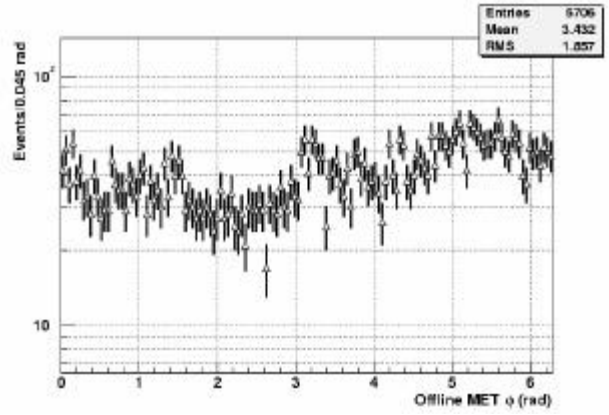
Timing window (TimeLo < in-time < TimeHi)ns
TimeLo set 20
TimeHi set 20

Energy Out-of-time cut (GeV) 40

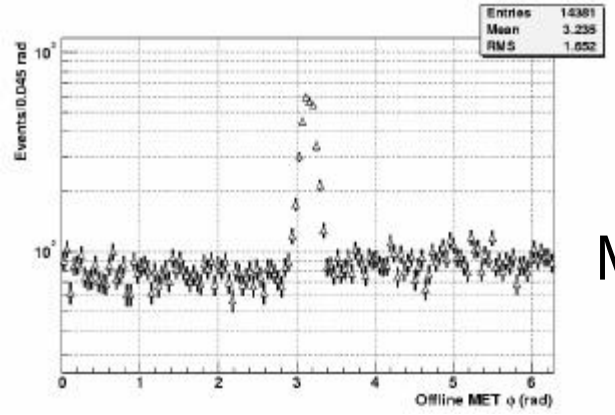
Charge fraction and EM fraction of the event
chf > 0.1 emf > 0.1
chf set 0.1
emf set 0.1

A.Kovalev, T.Munar

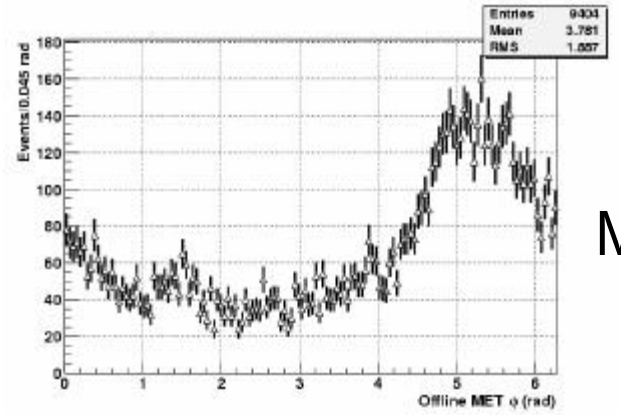
MET phi



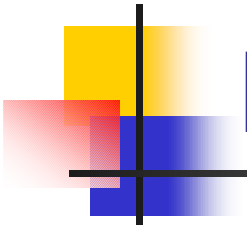
MET_35



MET_45



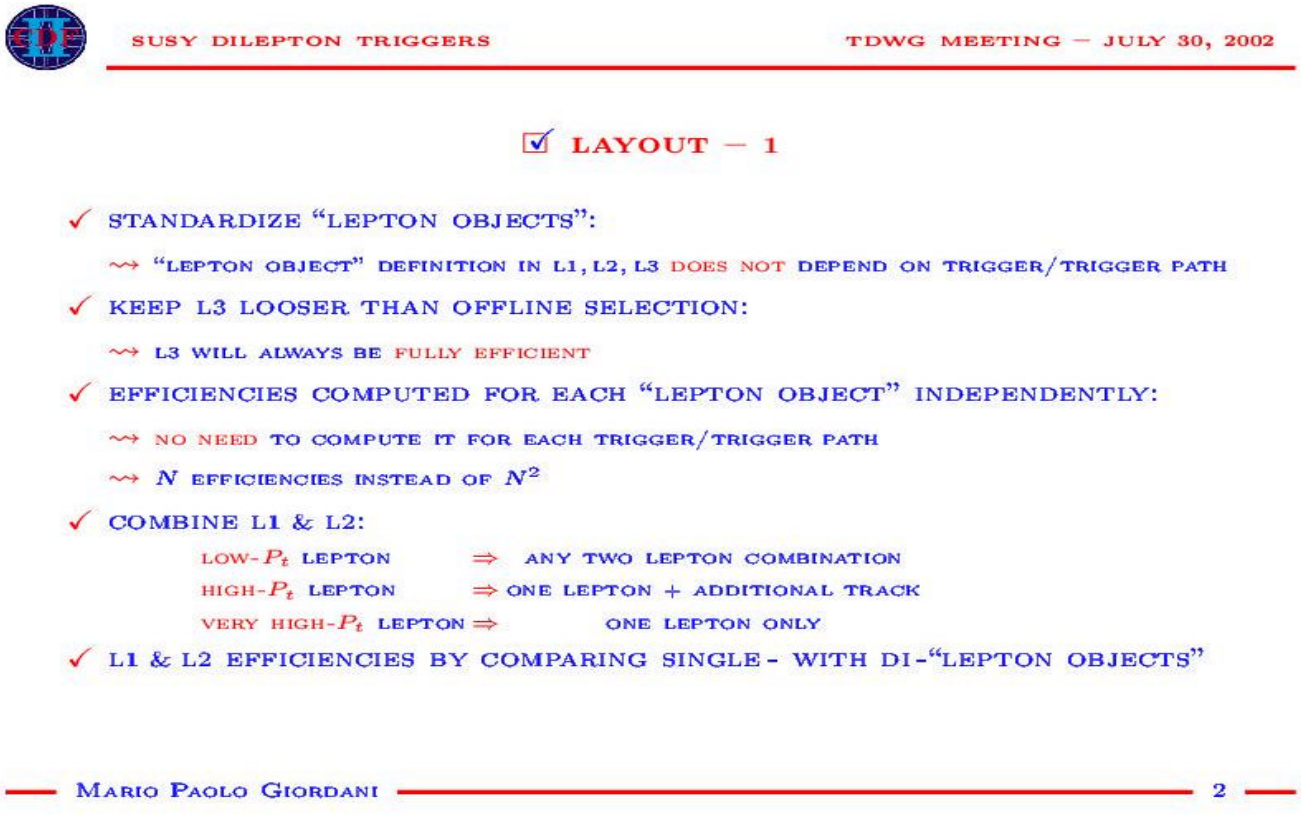
MET_HFO



MET

- for b) we now that met45 trigger has a lot of junk (50-70 %).
- Work is in progress on it right now in trying to understand whether we can reduce it at least on level 3. met + jets and especially met_bjet don't have that problem.

SUSY dileptons: revisioned and ready to go



SUSY DILEPTON TRIGGERS — TDWG MEETING — JULY 30, 2002

☑ LAYOUT — 1

✓ STANDARDIZE "LEPTON OBJECTS":

⇝ "LEPTON OBJECT" DEFINITION IN L1, L2, L3 DOES NOT DEPEND ON TRIGGER/TRIGGER PATH

✓ KEEP L3 LOOSER THAN OFFLINE SELECTION:

⇝ L3 WILL ALWAYS BE FULLY EFFICIENT

✓ EFFICIENCIES COMPUTED FOR EACH "LEPTON OBJECT" INDEPENDENTLY:

⇝ NO NEED TO COMPUTE IT FOR EACH TRIGGER/TRIGGER PATH

⇝ N EFFICIENCIES INSTEAD OF N^2

✓ COMBINE L1 & L2:

LOW-P_t LEPTON ⇒ ANY TWO LEPTON COMBINATION

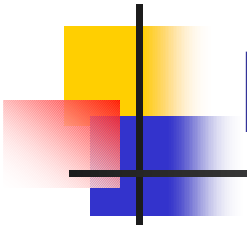
HIGH-P_t LEPTON ⇒ ONE LEPTON + ADDITIONAL TRACK

VERY HIGH-P_t LEPTON ⇒ ONE LEPTON ONLY

✓ L1 & L2 EFFICIENCIES BY COMPARING SINGLE- WITH DI-"LEPTON OBJECTS"

MARIO PAOLO GIORDANI — 2

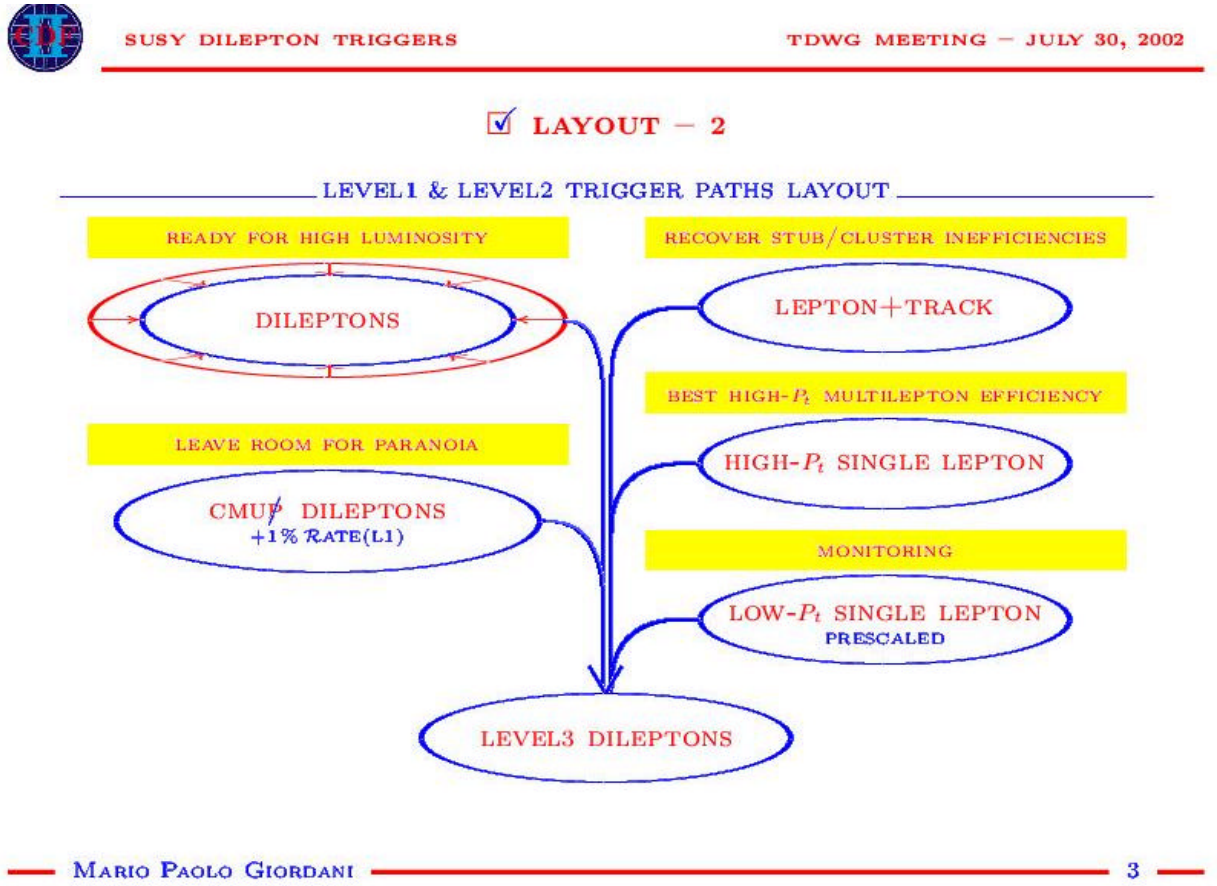
M. Giordani, S. Lammel



Dileptons

- The L1 & L2 dilepton trigger has then been structured in the following way:
  - core dileptons: apart from one path (central+plug electron path – we lowered the Pt threshold on the central electron), this is pretty much what is currently implemented;
  - dileptons without CMP requirements: provide more efficiency plus protection vs possible problems with CMP. These impact the *total* L1 trigger rate by 1%;
  - loose dileptons: essentially lepton+track, for recovering stub/cluster inefficiencies;
  - high-Pt inclusive lepton: provide extra efficiency + provide sample for efficiency computation;
  - low-Pt inclusive lepton (prescaled): provide low-Pt calibration sample.
- All these subsamples feed the same L3 dilepton filter.

SUSY dileptons



SUSY dileptons

SUSY DILEPTON TRIGGERS — TDWG MEETING – JULY 30, 2002

☑ **PROPOSAL**

(MODIFICATIONS WRT PHYSICS_1_02 HIGHLIGHTED IN RED)

LOW-P_t DILEPTON PATHS			
PATH		σ_{new} [nb]	σ_{old} [nb]
1 – CEM4_CMUP4			
L1	CMUP6_PT4	1800	1800
L2	CEM4_PT4_CES2	20	20
L3	CEM4_&_CMUP4	–	–
2 – CEM4_CMX4			
L1	CEM4_PT4_&_CMX1.5_PT2	210	210
L2	CEM4_PT4_CES2	90	90
L3	CEM4_&_CMX4	–	–
3 – CEM4_PEM8			
L1	CEM4_PT4	22000	1500
L2	CEM4_PT4_CES2_&_PEM8	50	120
L3	CEM4_&_PEM8	–	–
4 – CEM4_CEM4			
L1	CEM4_PT4	22000	930
L2	TWO_CEM4_PT4_CES2	125	125
L3	CEM4_&_CEM4	–	–

MARIO PAOLO GIORDANI — 4

SUSY dileptons

LOW-P_t DILEPTON PATHS / CONT'D			
PATH		σ_{new} [nb]	σ_{old} [nb]
5 – CMUP4_PEM8			
L1	CMUP6_PT4	1800	1800
L2	PEM8	10	10
L3	CMUP4_&_PEM8	–	–
6 – CMUP4_CMX4			
L1	CMUP6_PT4	1800	670
L2	AUTO	1800	670
L3	CMUP4_&_CMX4	–	–
7 – CMUP4_CMUP4			
L1	CMUP6_PT4	1800	1100
L2	AUTO	1800	1100
L3	CMUP4_&_CMUP4	–	–
8 – CMX4_PEM8			
L1	EM8_&_CMX1.5_PT2	110	110
L2	PEM8	30	30
L3	CMX4_&_PEM8	–	–

SUSY dileptons

CMP-FREE PATHS			
PATH		σ_{new} [nb]	σ_{old} [nb]
9 – CMU4_CEM4			
L1	CMU6_PT4	5000 (?)	–
L2	CEM4_PT4_CES2	50	–
L3	CMU4_&_CEM4	–	–
10 – CMU4_PEM8			
L1	CMU6_PT4	5000 (?)	–
L2	PEM8	25	–
L3	CMU4_&_PEM8	–	–
11 – CMU4_CMX4			
L1	CMU1.5_PT1.5_&_CMX1.5_PT2	670	670
L2	AUTO	670	670
L3	CMU4_&_CMX4	–	–
12 – CMU4_CMU4			
L1	TWO_CMU1.5_PT1.5	1100	1100
L2	AUTO	1100	1100
L3	CMU4_&_CMU4	–	–

SUSY dileptons

SUSY DILEPTON TRIGGERS — TDWG MEETING – JULY 30, 2002

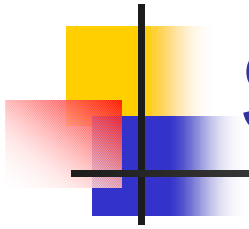
HIGH P_t LEPTON + TRACK PATHS			
PATH		σ_{new} [nb]	σ_{old} [nb]
13 – CEM8_TRK8			
L1	CEM8_PT8	1500	1500
L2	CEM8_PT8_CES2_&_TWO_TRK8	190	–
L3	CEM8_&_(CEM4_|_CMU4_|_CMP4_|_CMX4)	–	–
13 – CMUP8_TRK8			
L1	CMUP6_PT4	1800	1800
L2	AUTO	1800	1800
L3	CMUP8_&_(CEM4_|_CMU4_|_CMP4_|_CMX4)	–	–

VERY HIGH P_t LEPTON PATHS			
PATH		σ_{new} [nb]	σ_{old} [nb]
14 – CEM12			
L1	CEM8_PT8	1500	1500
L2	CEM12_PT8	350	–
L3	CEM12_&_(CEM4_|_CMU4_|_CMP4_|_CMX4_|_PEM8)	–	–
15 – CMUP8			
L1	CMUP6_PT4	1800	1800
L2	AUTO	1800	1800
L3	CMUP8_&_(CEM4_|_CMU4_|_CMP4_|_CMX4_|_PEM8)	–	–

MARIO PAOLO GIORDANI — 7

SUSY dileptons

LOW P_t LEPTON PATHS			
PATH		σ_{new} [nb]	σ_{old} [nb]
16 – CEM4_PS			
L1	CEM4_PT4	22000	22000
L2	CEM4_PT4_CES2_PS200	50	50
L3	CEM4_&_(CEM4_|_CMU4_|_CMP4_|_CMX4_|_PEM8)	–	–
17 – CMUP4_PS			
L1	CMUP6_PT4	1800	1800
L2	AUTO	1800	1800
L3	CMUP4_&_(CEM4_|_CMU4_|_CMP4_|_CMX4_|_PEM8)	–	–



SUSY dileptons

- The new triggers need to go into the physics table asap and then we will be able to answer questions b) and c).
- SUSY dileptons and trileptons are some of the Exotic flagship analysis

High pt b-jets

65	HIGGS_MULTI_JET:2	HIGH_PT_BJET
66	HIGH_PT_BJET:2	HIGH_PT_BJET
138	Z_BB:1	HIGH_PT_BJET

- For Z->bb see Patrizia's presentation

Higgs multijets

- A multijet trigger with relatively low thresholds on jet ET, enriched with heavy flavor decays by the request of a soft lepton tag or displaced tracks, will enable an independent search for Higgs boson associated production and decay into b-quark pairs.
- Multijet events may also be the search field for several supersymmetric signatures, and they substantially help collecting ttbar decays; a single top signal may also be sought with a few fb-1.

http://home.fnal.gov/~dorigo/multijet.html

Higgs multijets

- Multijet + soft lepton tag:
  - Level 1 :single tower trigger with ET > 10 GeV -accept rate has been verified to be 2.5 kHz.
  - Level 2, three calorimeter clusters exceeding 10 GeV are requested, plus a sum of transverse energy of all clusters above 90 GeV --accept rate has been shown to be close to the predicted value, 15 Hz.
  - Level 3, a search for electron and muon tags of the jets can be performed, lowering the rate by an order of magnitude.

cdf_note 5485

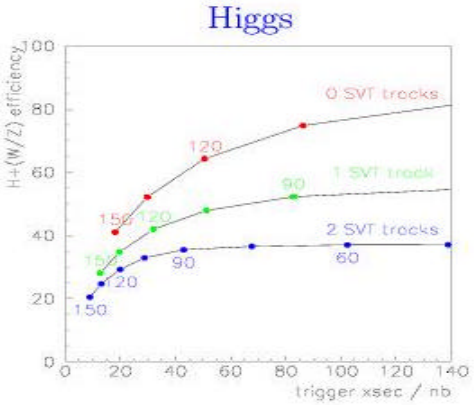
- Multijets + SVT:
  - Level 1 :single tower trigger with ET > 10 GeV -accept rate has been verified to be 2.5 kHz.
  - Level 2, three calorimeter clusters exceeding 10 GeV are requested, plus a sum of transverse energy of all clusters above 90 GeV + 2 SVT tracks with impact parameter larger than 100 microns -- estimated input rate to Level 3 of about 1.5 Hz.
  - At Level 3 it should thus be possible to operate a full tracking reconstruction, to obtain a small high-purity sample of heavy flavor decays.

cdf_note 5534

Higgs Multijets

Recent developments (Roma group):

It could seem that Calorimeter only is better than requiring the 2 SVT tracks. On the other hand the efficiencies have not been calculated yet after the analysis cuts.



Suggestion:

- Level 1: 1 10 GeV tower
- Level 2: 3 10 GeV clusters and $\Sigma E_T^{10} \geq 120$ [105] GeV
- trigger X-sec: 51 [86] nb
- efficiency H+(W/Z) → qqbb: 64 [75] %
- efficiency hadr. single top: 61, 68 [73,78] %

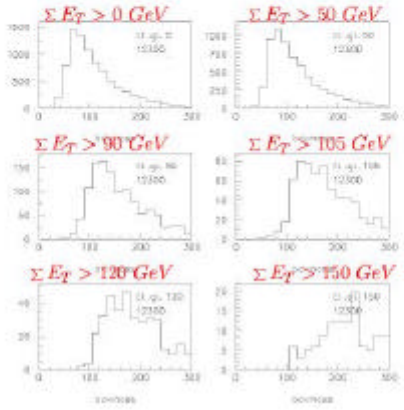
• present HIGGS_MULTI_JET:

- Level 1: 1 10 GeV tower, $\Sigma E_T \geq 90$ GeV
- Level 2: 2 SVT tracks, $d_0 > 100\mu m$
- trigger X-sec: 115 nb
- efficiency H+(W/Z) → qqbb: 38 %
- efficiency hadronic single top: 26, 38 %

some points to consider/future plans:

- efficiency for events with offline SECVTX tag
- QCD background becomes more signal–like – problems later in analysis?

QCD bckg: inv. mass of 3 jets with highest E_T.



Trigger status

Needs to include
the 3 clusters requirement

1. **Path** HIGGS_MULTI_JET_v-3
    1. **Trigger** L1_JET10_&_SUMET90_v-1 Bit: [28]
        1. **Specific option** L1_JET10_v-1 **Instance** of JET.
            1. NUMBER = 1
            2. ET_PLUG = 10 GeV
            3. ET_CENTRAL = 10 GeV

        Generated Down Load (Instance of JET):
            1. DIRAC_CRATESUM_BIT_CONTENT = 1 integer
            2. DIRAC_CRATESUM_BIT_NO = 5 integer
            3. DIRAC_MEMORY_BIT_NO = 5 integer
            4. FRED_INPUT_BIT = 28 integer
            5. PREFRED_OUTPUT_BIT = 9 integer
            6. PREFRED_INPUT_BIT = 5 integer
            7. DIRAC_CRATESUM_WIRE_NO = 5 integer
        2. **Specific option** L1_SUMET90_v-1 **Instance** of SUMET.
            1. ET = 90 GeV
            2. SUMET_THRESH_CENTRAL = 1 GeV
            3. SUMET_THRESH_PLUG = 1 GeV

        Generated Down Load (Instance of SUMET):
            1. FRED_INPUT_BIT = 29 integer
            2. PREFRED_OUTPUT_BIT = 0 integer
            3. PREFRED_INPUT_BIT = 0 integer
    2. **Trigger** L2_TWO_TRK2_D100_L1_JET10_&_SUMET90_v-1 Bit: [90]
        1. **Specific option** L2_TWO_TRK2_D100_v-2 **Instance** of SvtTrack.
            1. NUMBER = 2
            2. SVT_CHI2 = 25
            3. SVT_DMAX = 1000 microns
            4. SVT_DMIN = 100 microns
            5. SVT_PT = 2 GeV/c
    3. **Trigger** L3_THREE_JET10_SUMET100_TWO_SVT_v-1
        1. **L3 Instance:** run1SpikeKiller, of **class** CalorimetryModule_v-1
            1. plus one null.
        2. **L3 Instance:** cone0.4, of **class** JetCluModule_v-2
            1. coneRadius = 0.4
            2. vertexStrategy = 0
        3. **L3 Instance:** metZequals0, of **class** CdfMetModule_v-1
            1. vertexStrategy = 0
        4. **L3 Instance:** jetHiggs_v1, of **class** L3JetFilterModule_v-1
            1. RcpJetCloneName = cone0.4
            2. jetAlgorithm = JetClu
            3. jetFilterType = 2
            4. minimumJetEtForSumEt = 10.0
            5. sumEtCut = 100

Photons

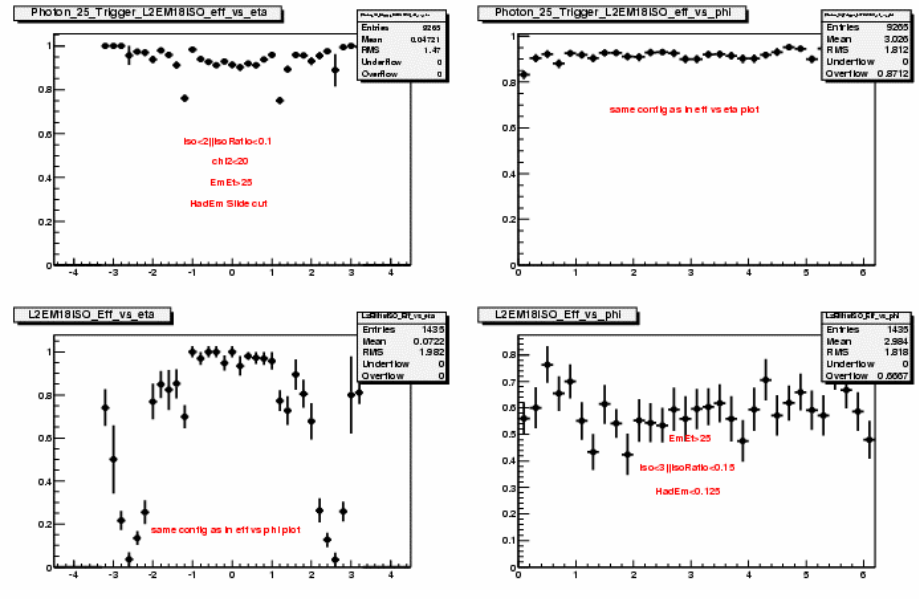
- PHYSICS_1_02 [2,131,312] 150010 8/15/2002

Bit	trigger_path	dataset	#evts in run that fired	rate(Hz)	xsect	stream	#evts in stream
45	DIPHOTON_12:6	OTHER_PHOTON	65	0.01	1.17	StreamC	21,950
46	DIPHOTON_18:5	EXPRESS	148	0.03	2.67	StreamA	5,873
46	DIPHOTON_18:5	OTHER_PHOTON	148	0.03	2.67	StreamC	21,950
104	PHOTON_10_ISO:5	OTHER_PHOTON	106	0.02	1.91	StreamC	21,950
105	PHOTON_15_TIGHT:4	HIGH_ET_PHOTON	1,332	0.27	24.05	StreamC	21,950
106	PHOTON_25_ISO:6	HIGH_ET_PHOTON	1,801	0.36	32.52	StreamC	21,950
107	PHOTON_25_ISO_TRACK_5_ISO:1	HIGH_ET_PHOTON	530	0.11	9.57	StreamC	21,950
108	PHOTON_B_JET:5	HIGH_ET_PHOTON	717	0.15	12.95	StreamC	21,950
109	PHOTON_CMUP:3	OTHER_PHOTON	41	0.01	0.74	StreamC	21,950
110	PHOTON_CMX:5	OTHER_PHOTON	51	0.01	0.92	StreamC	21,950
111	PHOTON_DIJET:7	OTHER_PHOTON	515	0.10	9.30	StreamC	21,950
112	PHOTON_L1_EM8:3	OTHER_PHOTON	301	0.06	5.44	StreamC	21,950
113	PHOTON_L3PS100_L2_EM18_ISO:1	OTHER_PHOTON	216	0.04	3.90	StreamC	21,950
124	SUPER_PHOTON70_L2_EM:3	HIGH_ET_PHOTON	85	0.02	1.53	StreamC	21,950
125	SUPER_PHOTON70_L2_JET:3	HIGH_ET_PHOTON	79	0.02	1.43	StreamC	21,950
131	TRIPHOTON:6	OTHER_PHOTON	44	0.01	0.79	StreamC	21,950
136	ULTRA_PHOTON50:5	EXPRESS	435	0.09	7.85	StreamA	5,873
136	ULTRA_PHOTON50:5	HIGH_ET_PHOTON	435	0.09	7.85	StreamC	21,950

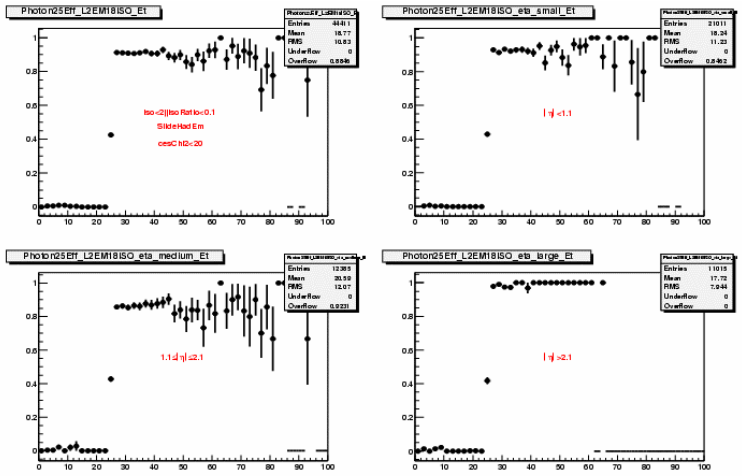
Photons

Possible fine-tuning questions which we could look into for the trigger, but they are not a priority right now.
The L2 Had/EM cut on EM_70 will be removed at some point and we need to check that is done.
Overall since the gamma-b started we have all the triggers we proposed and we don't know of any particular issues.

Photons (4.5.2)



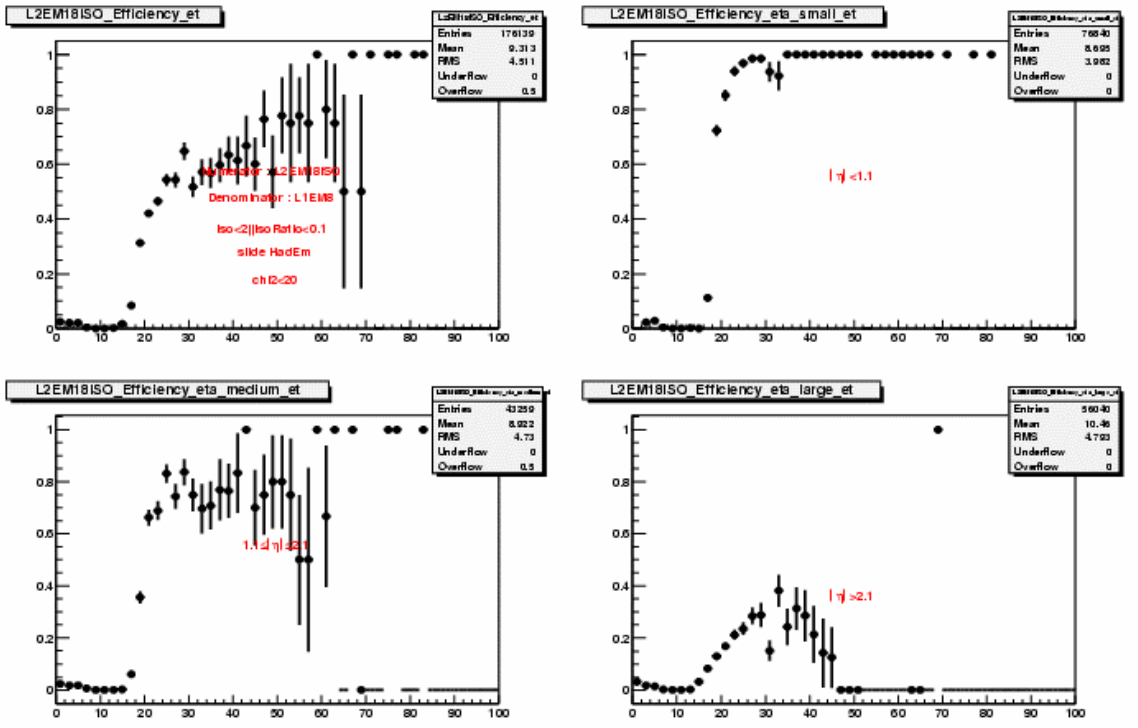
L2/L1 and L3/L2 efficiencies vs eta and phi

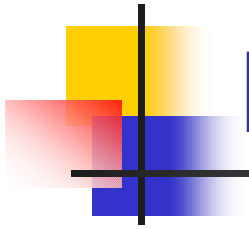


L3/L2 eff vs Et for total and different eta regions

Photons (4.5.2)

L2/L1 effi vs Et for total and different eta regions





Photons

Photon triggers latest news at:

http://www-cdf.fnal.gov/internal/physics/photon/trigger.html

Lepton+Track

- group plans for winter conferences

(http://ncdf43.fnal.gov/~safonov/CDFLepton+TrackGroupWeb/lepton_track_main.htm)

  - 1) Use the lepton + track triggers to analyze Z -> tau tau, where one tau decays electronically and the other decays hadronically. At the same time, and for trigger validation purposes, we will analyze Z->ee. Pasha is working on W->$\nu\tau$. These should be blessed in the EWK group. Wish for these analyses to be included in the combined W and Z publication.

  - 2) Search for the SUSY production of stop pairs, followed by the RPV SUSY decay stop --> tau b. One tau decays to electron (or muon) and the other decays hadronically.

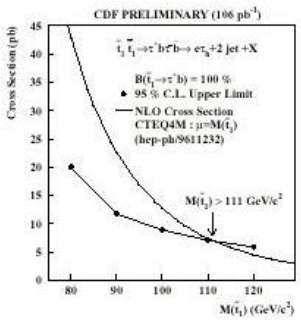
Tau datasets will need to be reprocessed with the final offline version and request the use of the farms to help with this. Appreciable disk space will be needed to store data and MC samples.

Lepton + track: physics goals

Tau Physics: Lepton+Track

Davis, Paris, Texas A&M, Waseda

- Calibration:
  - $Z \to \tau_e \tau_h$; $Z \to \tau_\mu \tau_h$; $Z \to ee$; $Z \to \mu\mu$;
- Analysis:
  - $t\bar{t} \to 2 \times (Wb \to e/\mu/\tau) \to (e/\mu)\tau + bb$
  - mSUGRA (small/large *tanβ*) $\chi^{\pm}\chi^{0} \to e(\mu)\tau\tau$ …
  - $\not{R}_p$ SUSY: $\tilde{t}\,\tilde{t} \to (b\tau)\,(b\tau)$
  - $\not{R}_p$ SUSY: $\tilde{\nu} \to \mu\tau$
  - GMSB scenario: $\tilde{\tau}$ is NLSP
  - Lepton Flavor Violating $gg \to H \to \mu\tau$
  - MSSM Higgs (large *tanβ*) $H^0/h^0/A^0 \to \tau\tau$;



Alexei Safonov, CDF Collaboration Meeting, January 25, 2002

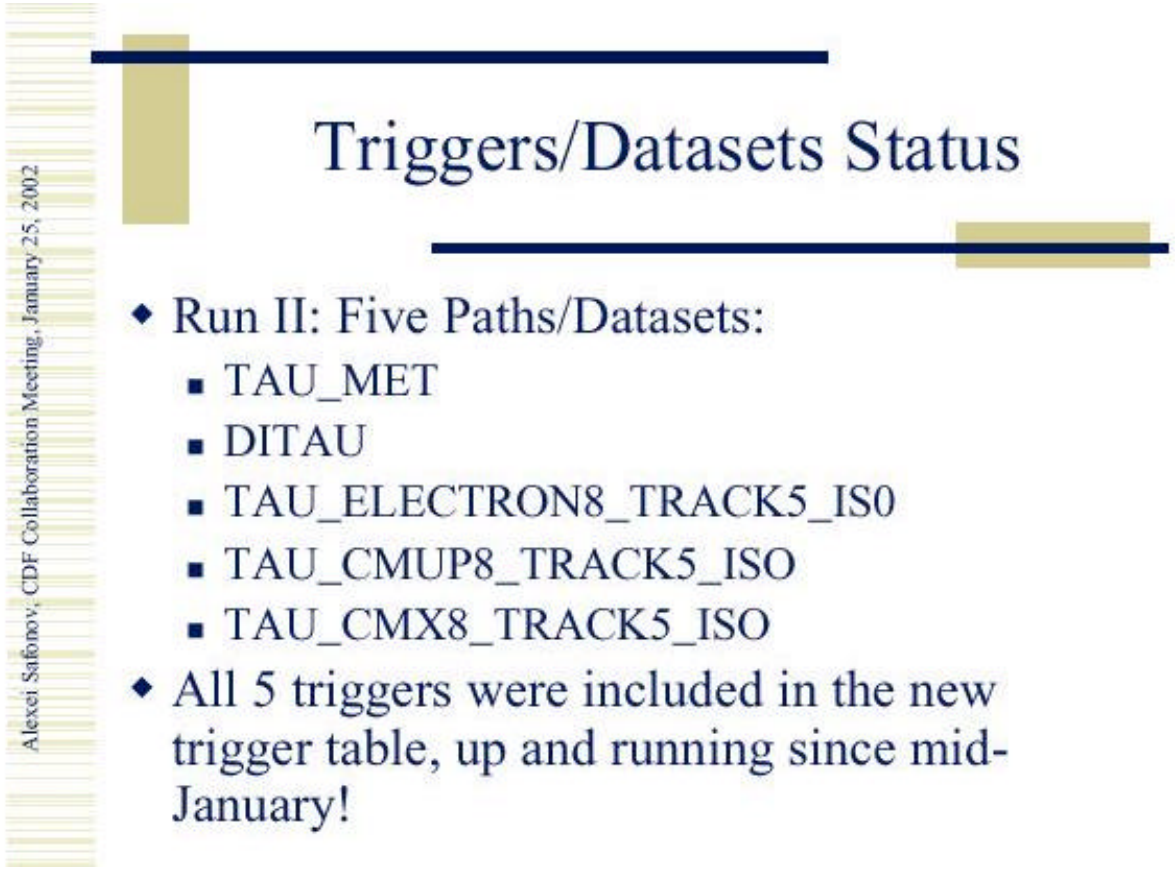
Tau Physics: Di-τ & τ+$\not{E}_T$

Fermilab, Rutgers

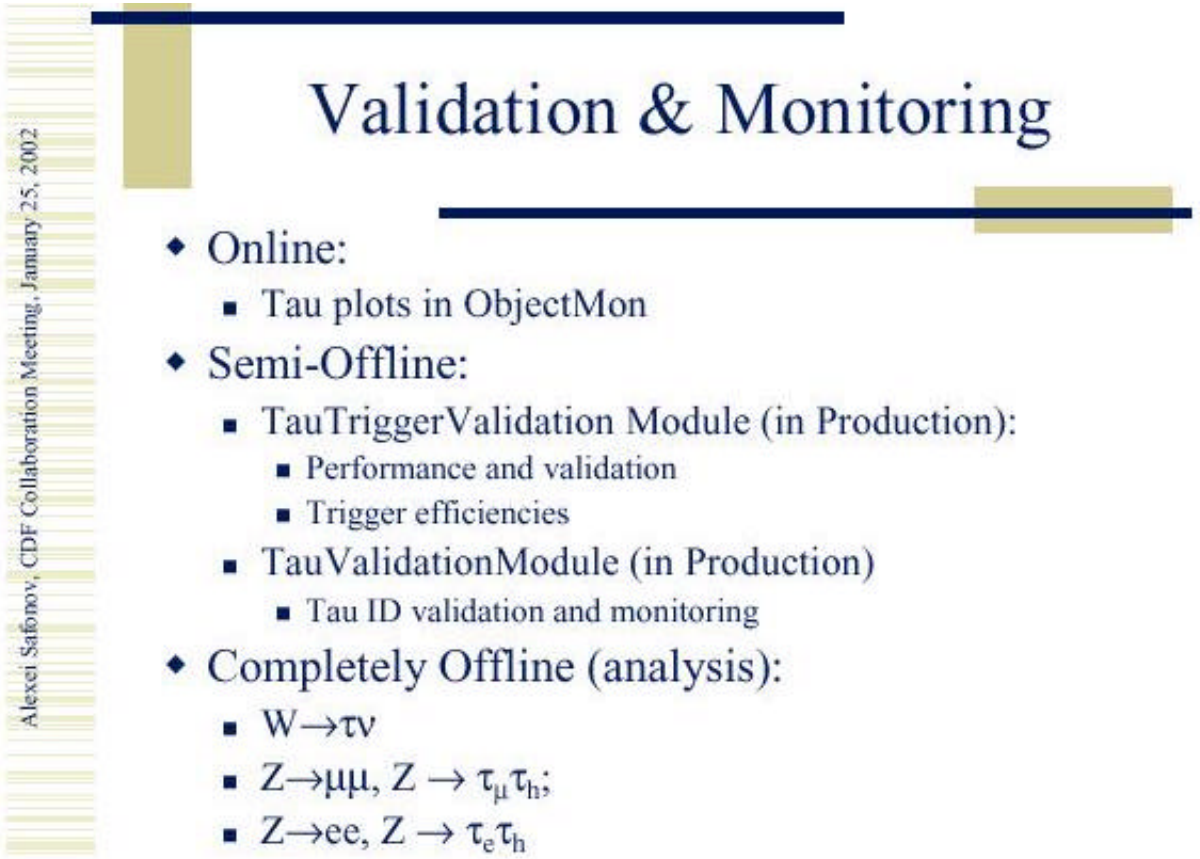
- τ+MET:
  - $Br(W \to \tau\nu)/Br(W \to e\nu)$
  - $t\bar{t} \to H^{+}b \to l + \tau + Met + b_{tag}$
- Di-τ:
  - mSUGRA (small/large *tanβ*) $\chi^{\pm}\chi^{0} \to e(\mu\tau)\tau_h\tau_h$ …
  - $Z \to \tau\tau$; $H(W/Z) \to \tau\tau$+leptons(jets)…;
  - $H^0/h^0/A^0 \to \tau\tau$;
  - $t\bar{t} \to (H^{+}b)\,(H^{-}b) \to \tau\tau + Met + bb$
- The 5 triggers are complementary.

Alexei Safonov, CDF Collaboration Meeting, January 25, 2002

Lepton + track and taus



Lepton + track



Lepton + Track

- b) What is the S/B for each trigger path? Can cuts be changed at any level to improve S/B?

S/B depends on what you are looking for. On the example of Z -> tautau, typically we have about 2 very clean events per every 3 pb-1 in integrated luminosity. The trigger cross-section is of the order of 10-30 nb. S/B~1 pb/nb. As for optimization, I think we are mostly done and further cuts will start taking out the acceptance.

Lepton + Track

- c) What additional trigger capabilties would improve the situation, how and by how much? For instance, removal of the 12kHz limit, level 2 muon board, Si tracking at level 3.

- L2 muon harware will remove unjustifiably large muon rates before L3.

Conclusions

tau/lep+track	good shape
MET	lots of work going on – more in the next month
Photon	good shape
multi-lepton	needs new triggers
high pt lepton	ok
high pt bjet	needs trigger changes to be put in place